



**Canal &
River Trust**

Making life better by water

Bridge Owners' Forum - BOF 68

Is there a link between bridge failures and condition?

Andy Featherby
Highway Structures
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Canal & River Trust's Bridge Portfolio

	Arch	Flat Deck	Swing	Lift	Rolling	Total
002 Accommodation	1059	420	107	54	0	1640
003 Public Road	635	167	44	19	0	865
004 Towpath/Turnover	110	324	17	4	1	456
Total	1804	911	168	77	1	2961

- The portfolio reported to Defra totals 2970 bridges.
- Bridges included in the Defra reports but excluded from the strategy are:
 - Accommodation Bridges 1 no.
 - Public Road Bridges 6 no. (includes 5 no. River Weaver swing bridges)
 - Towpath/Turnover Bridges 2 no.

Condition & COF by Principal Bridge Asset Type

Accommodation Bridges

	A	B	C	D	E
CoF 1	23	156	460	103	13
CoF 2	28	179	507	104	8
CoF 3	6	20	25	4	1
CoF 4	0	1	2	0	0
CoF 5	0	0	0	0	0
Total	57	356	994	211	22
1640	3%	22%	61%	13%	1%

Public Road Bridges

	A	B	C	D	E
CoF 1	1	34	38	6	1
CoF 2	9	253	233	30	0
CoF 3	3	75	83	17	0
CoF 4	1	44	33	3	0
CoF 5	0	0	0	1	0
Total	14	406	387	57	1
865	2%	47%	45%	7%	0%

Towpath Turnover Bridges

	A	B	C	D	E
CoF 1	16	84	120	32	2
CoF 2	26	50	83	20	2
CoF 3	1	3	8	7	1
CoF 4	0	1	0	0	0
CoF 5	0	0	0	0	0
Total	43	138	211	59	5
456	9%	30%	46%	13%	1%

Condition & COF by Structure Type

Arch Bridges

	A	B	C	D	E
CoF 1	3	140	423	77	9
CoF 2	10	283	562	88	5
CoF 3	2	55	79	12	0
CoF 4	1	30	25	0	0
CoF 5	0	0	0	0	0
Total	16	508	1089	177	14
1804	1%	28%	60%	10%	1%

Flat + Movable Bridges

	A	B	C	D	E
CoF 1	37	134	195	64	7
CoF 2	53	199	261	66	5
CoF 3	8	43	37	16	2
CoF 4	0	16	10	3	0
CoF 5	0	0	0	1	0
Total	98	392	503	150	14
1157	8%	34%	43%	13%	1%

All Bridges

	A	B	C	D	E
CoF 1	40	274	618	141	16
CoF 2	63	482	823	154	10
CoF 3	10	98	116	28	2
CoF 4	1	46	35	3	0
CoF 5	0	0	0	1	0
Total	114	900	1592	327	28
2961	4%	30%	54%	11%	1%

Public Road Bridge Failure Rates

Do these correlate with condition?

Causes of Failure

- Overloading
- Scour
- Impact
- Safety Critical
- Hidden Fixings and Defects

Trust PRB Failure History

Tacit knowledge and Trust records dating back to 1994. 4 public road bridge failures over 27 years.

Annual Rate= $4/(871 \times 27) = 0.00017$ or likely 1 failure every 6.75 years

Bridge Name	Reference	Date of Failure	Condition Grade at Failure	Type and Cause
Elland	CA-006-002	2015	B	Arch: Scour of dry abutment after river overtopped into canal.
Plank Lane	LE-009-003	2006	C	Lift: Hidden Fixing, Overhead Counterweight
Wykewell	FK-010-002	2019	C	Lift: Hidden Fixing, Hanger rod end
Basford	CL-020-003	2020	B	Arch: Impact on parapet leading to failure of spandrel

Elland Bridge (CA-006-002)

Failure Mode - Scour



Plank Lane Lift Bridge (LE-009-003)

Failure Mode : Safety Critical Hidden Fixings



Wykewell Lift Bridge (FK-010-002)

Failure Mode : Safety Critical Hidden Fixings



Basford Bridge (CL-020-003)

Failure Mode : Impact Damage



Bridge Failure Rates: Research & Consultation

Research

- Reference to current UK Bridges Board research and papers readily available on the internet indicates that annual bridge failure rates are of the order of 2×10^{-4} and that scour is the most common cause of failure.
- A national study from the United States (1) determined an overall annual failure rate of 0.00021

Consultation

- UK Bridges Board members have been consulted (October 2021) and responses to date are in line with Trust experience and findings. Scour is most common cause as the majority of bridges are fixed and there is currently no proven link between condition and sudden failure.
- The subject is included on the agenda of the Bridge Owners' Forum and more research data may come to light after that (hopefully).

Public Road Bridge Failure Rates: Interim Conclusions

1. The main causes of sudden failure can affect bridges in any condition.
2. Failure rates of Trust bridges are overall the same order as other bridge owners.
3. Scour is the most common cause of sudden failure for fixed bridges.
4. Movable bridges are more susceptible to failure of safety critical fixings or hidden defects and have a failure rate an order higher than fixed bridges.
5. Bridge engineers are aware that certain types of bridge are more susceptible to certain failure modes and asset management plans for those structures are developed accordingly.
6. Further consultation may identify additional research papers which could help establish whether there is any correlation between poorer condition bridges and a higher likelihood of failure.